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(54) **DEVELOPING DEVICE AND IMAGE FORMING APPARATUS**

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G03G 15/08 (2006.01)

(52) **U.S. Cl.**
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(58) **Field of Classification Search**
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USPC 399/254, 256
See application file for complete search history.

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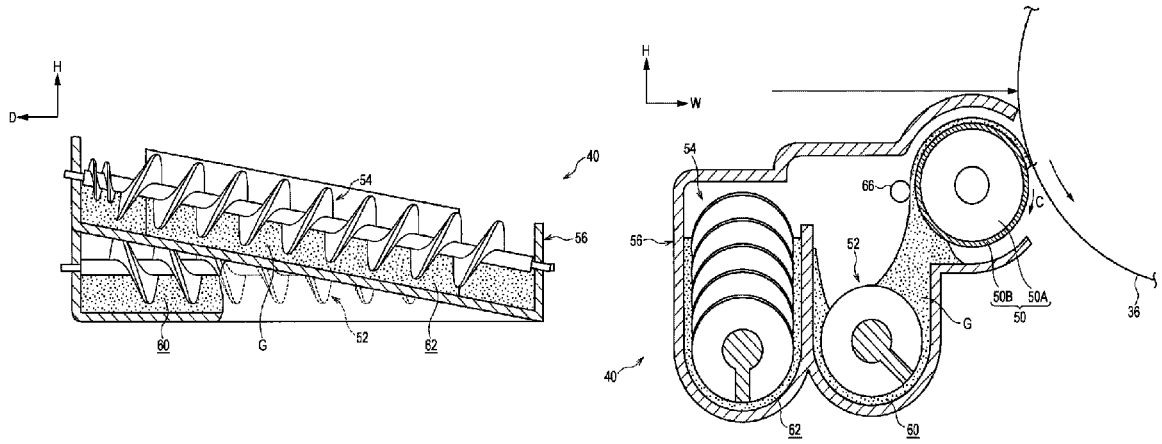
(57) **ABSTRACT**

A developing device includes a developing member that delivers a developer to an image carrier while rotating, a transport-supply member that extends in one direction and that supplies the developer, which contains a toner, to the developing member while transporting the developer from a first side to a second side in the one direction, and a transport-stirring member that is disposed along a transport-stirring path, which is inclined in an upward direction with respect to a horizontal direction, the transport-stirring member being configured to receive the developer, which is transported by the transport-supply member, from a portion of the transport-supply member on the second side in the one direction, stir the received developer while transporting the developer upward along the transport-stirring path, and deliver the developer to a portion of the transport-supply member on the first side in the one direction.

4 Claims, 8 Drawing Sheets



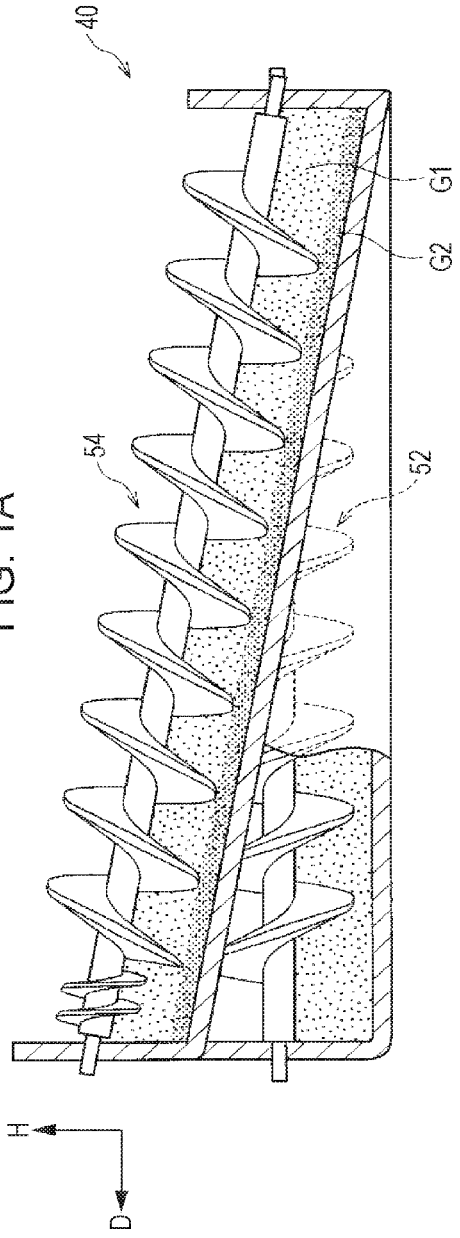


FIG. 1A

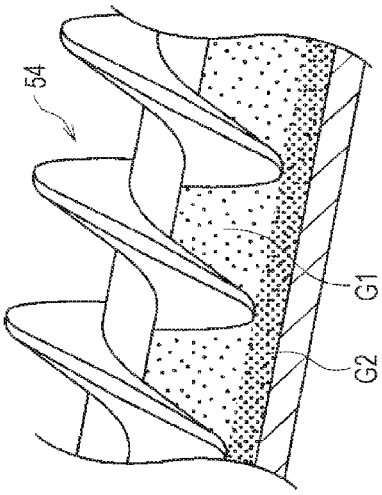
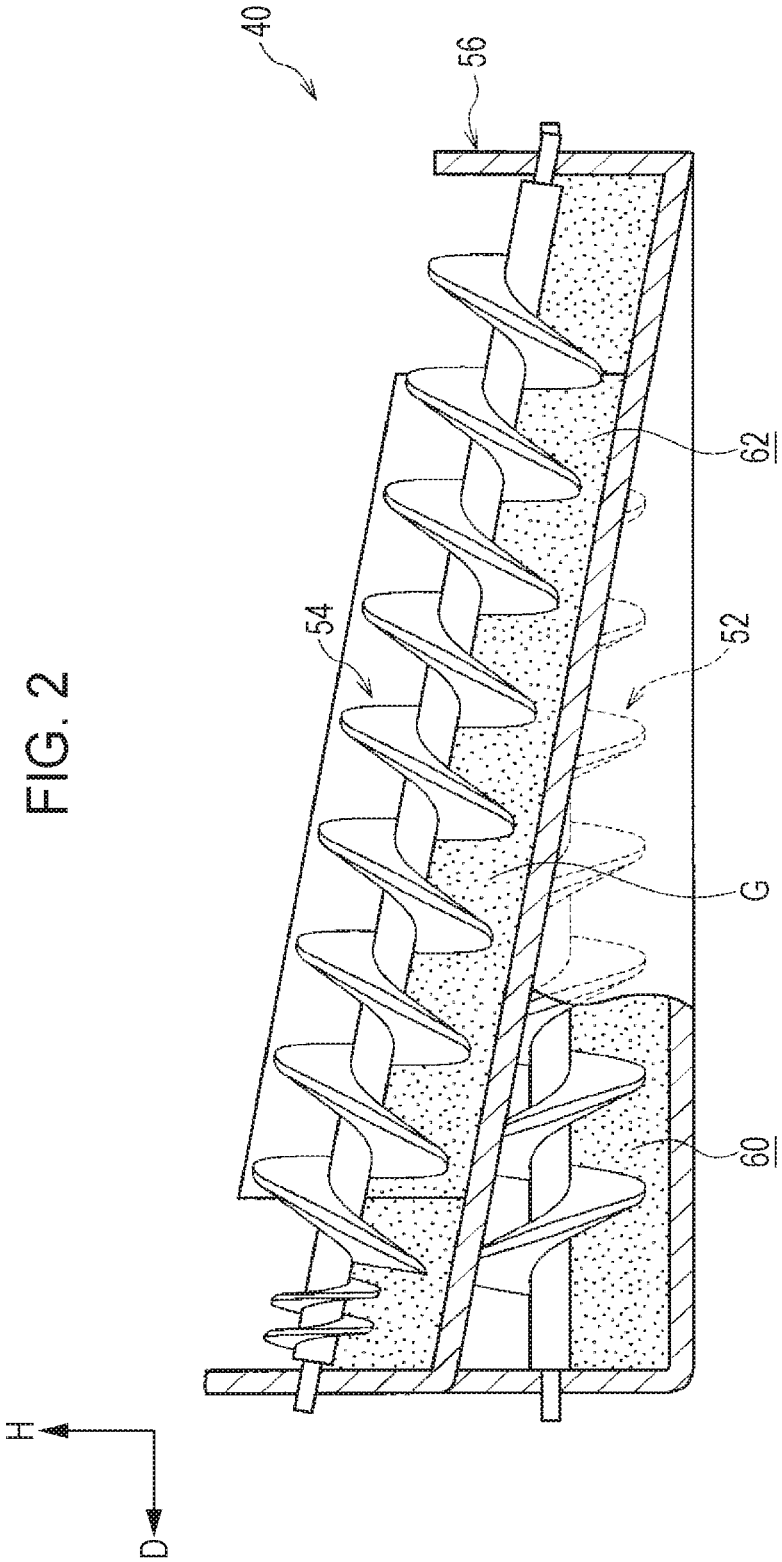


FIG. 1B

FIG. 2



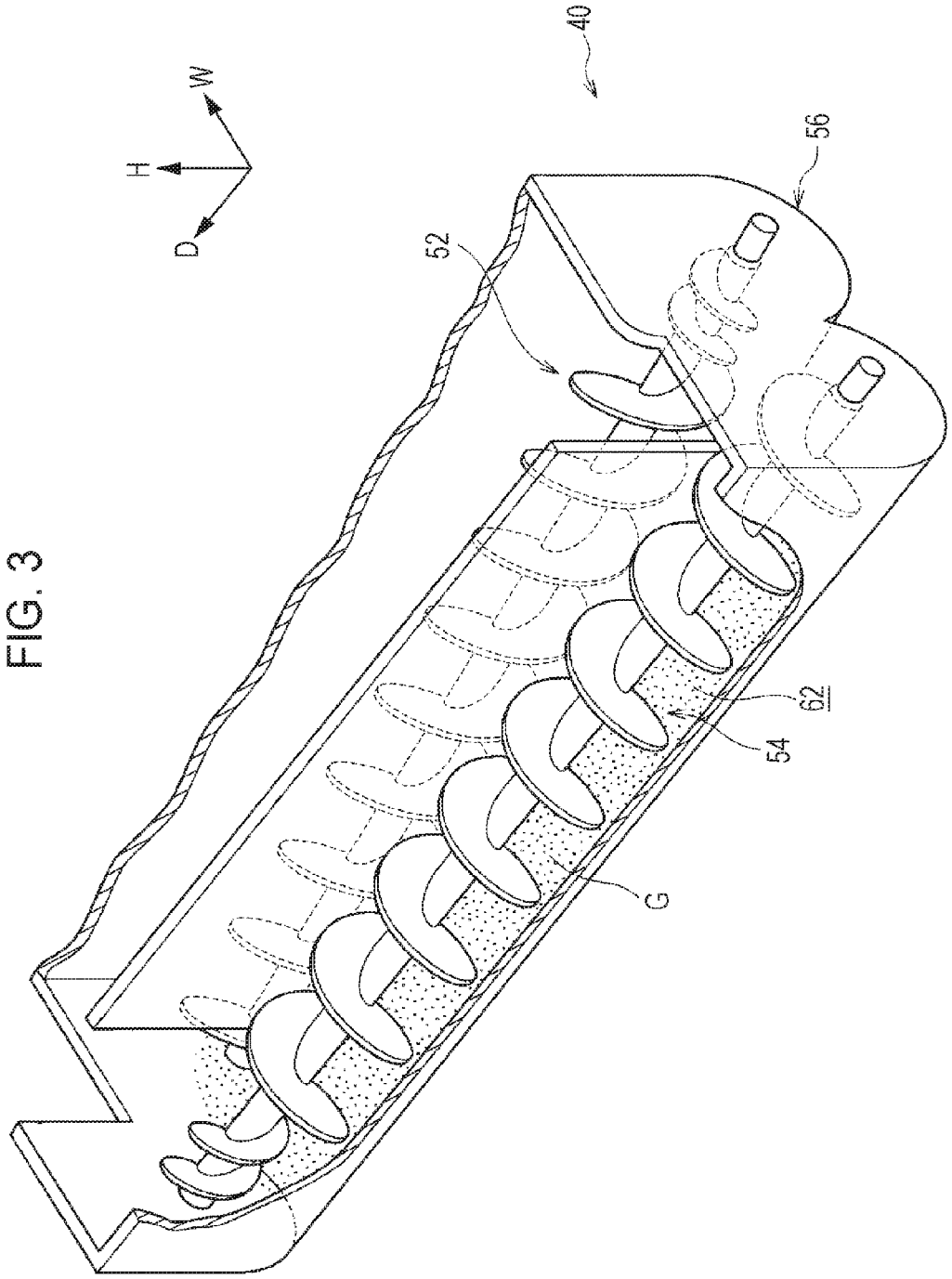


FIG. 3

FIG. 4

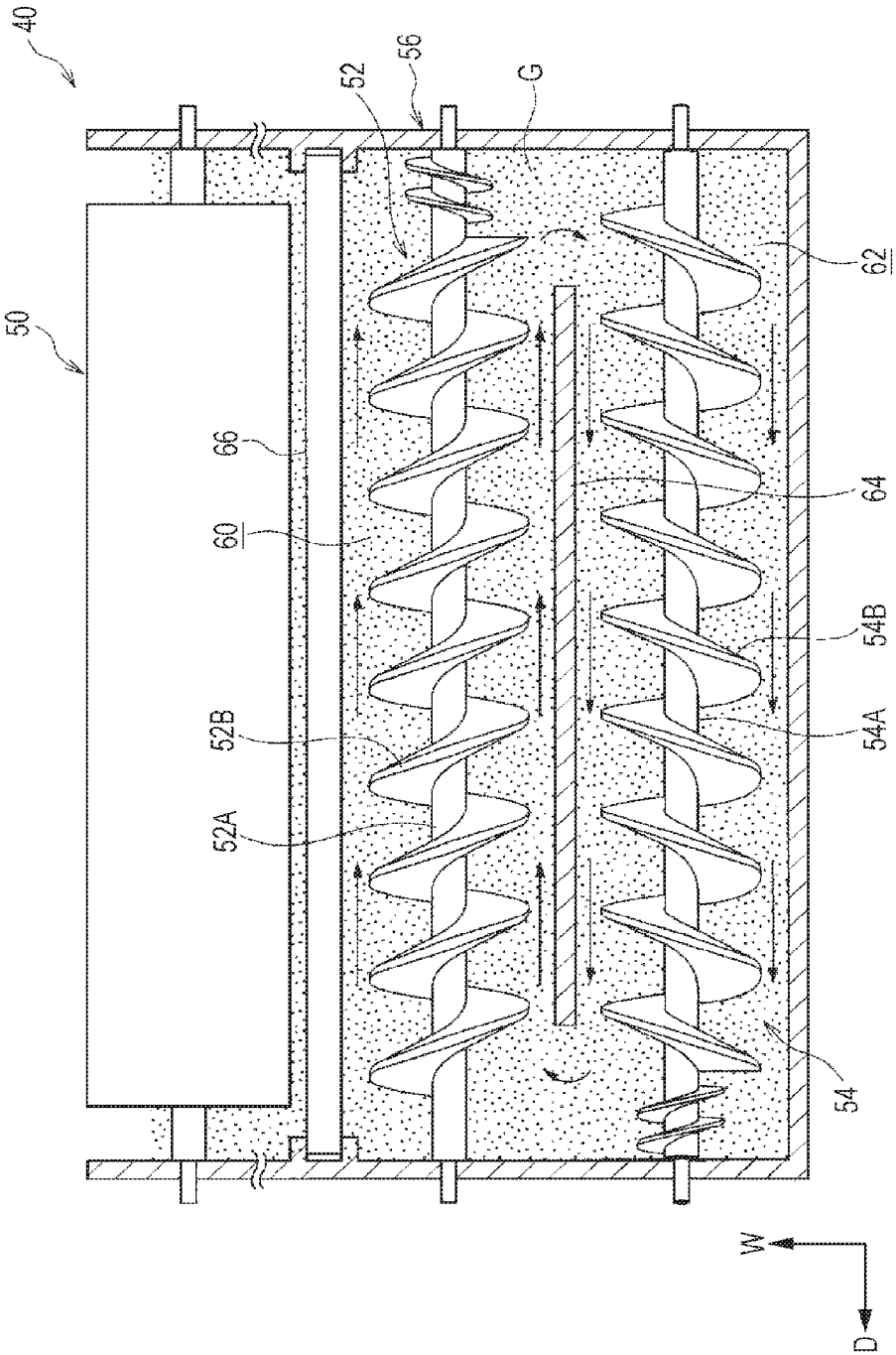


FIG. 5

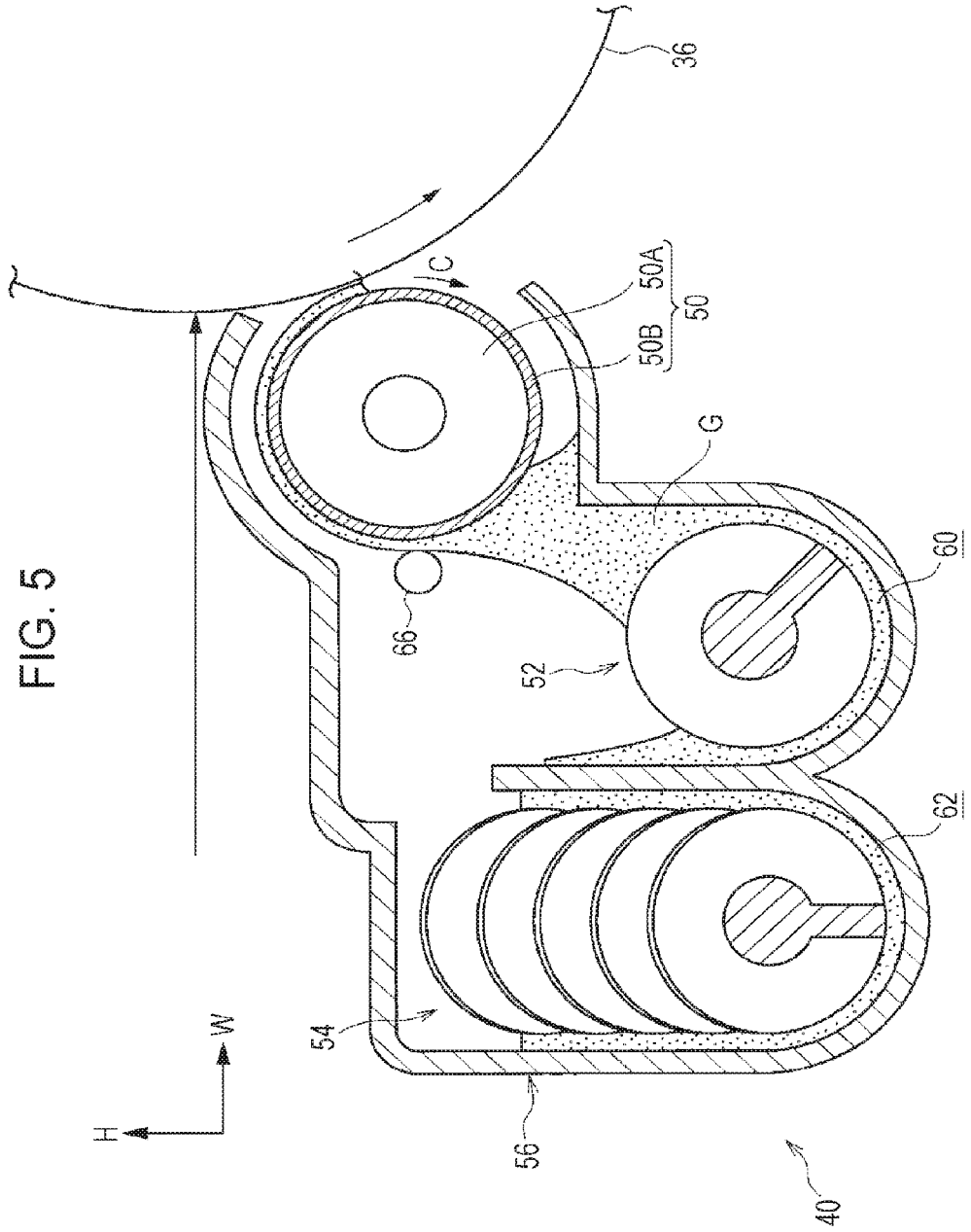
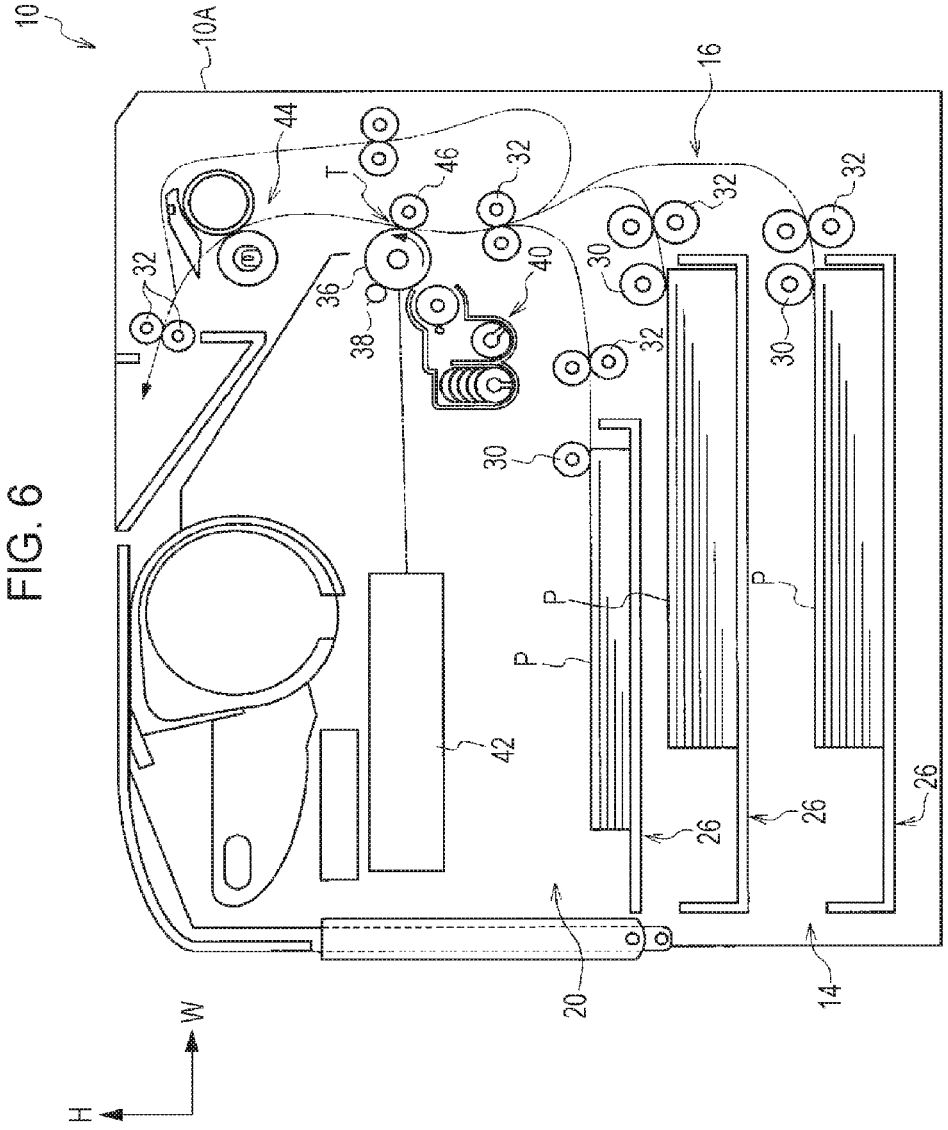


FIG. 6



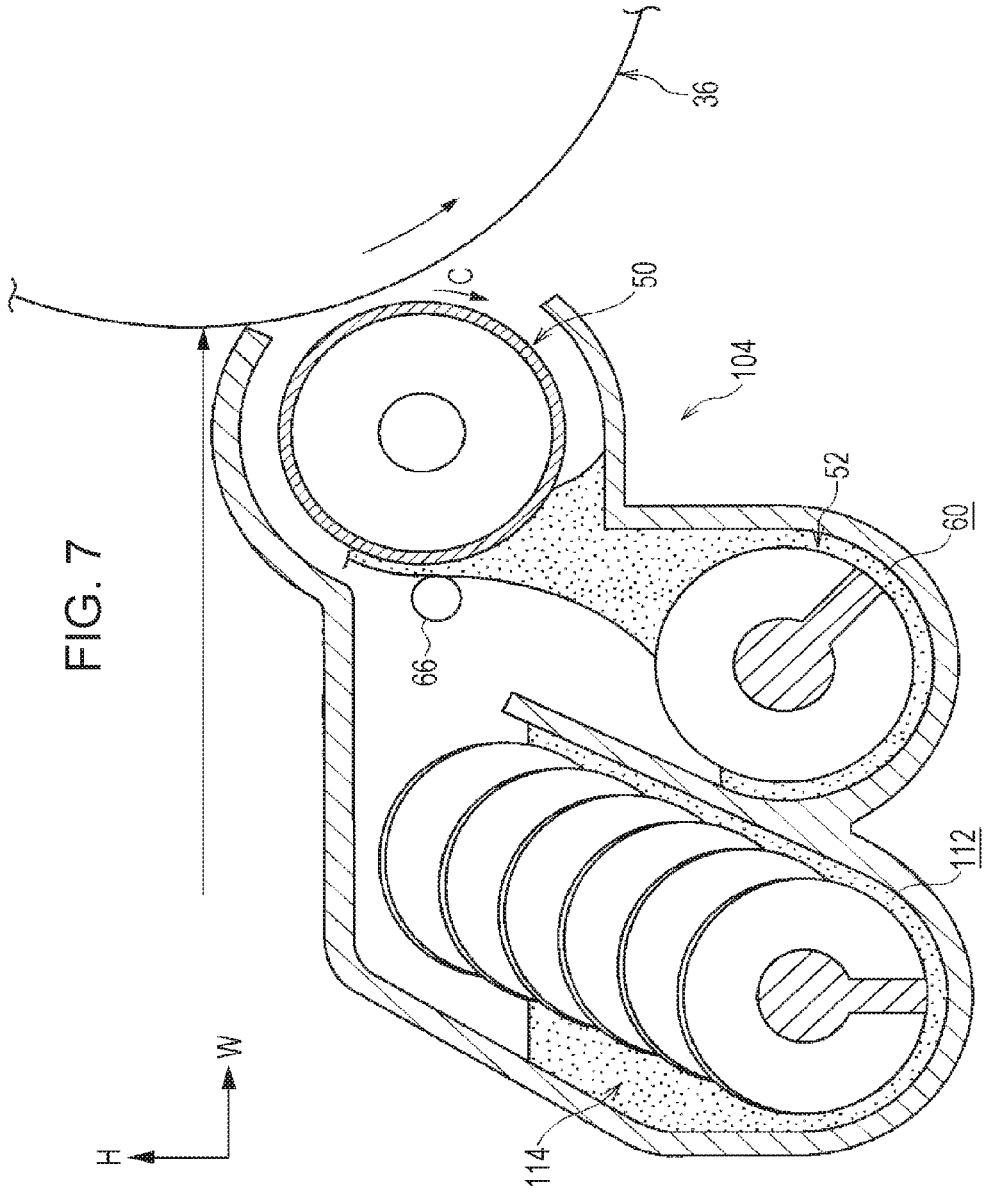
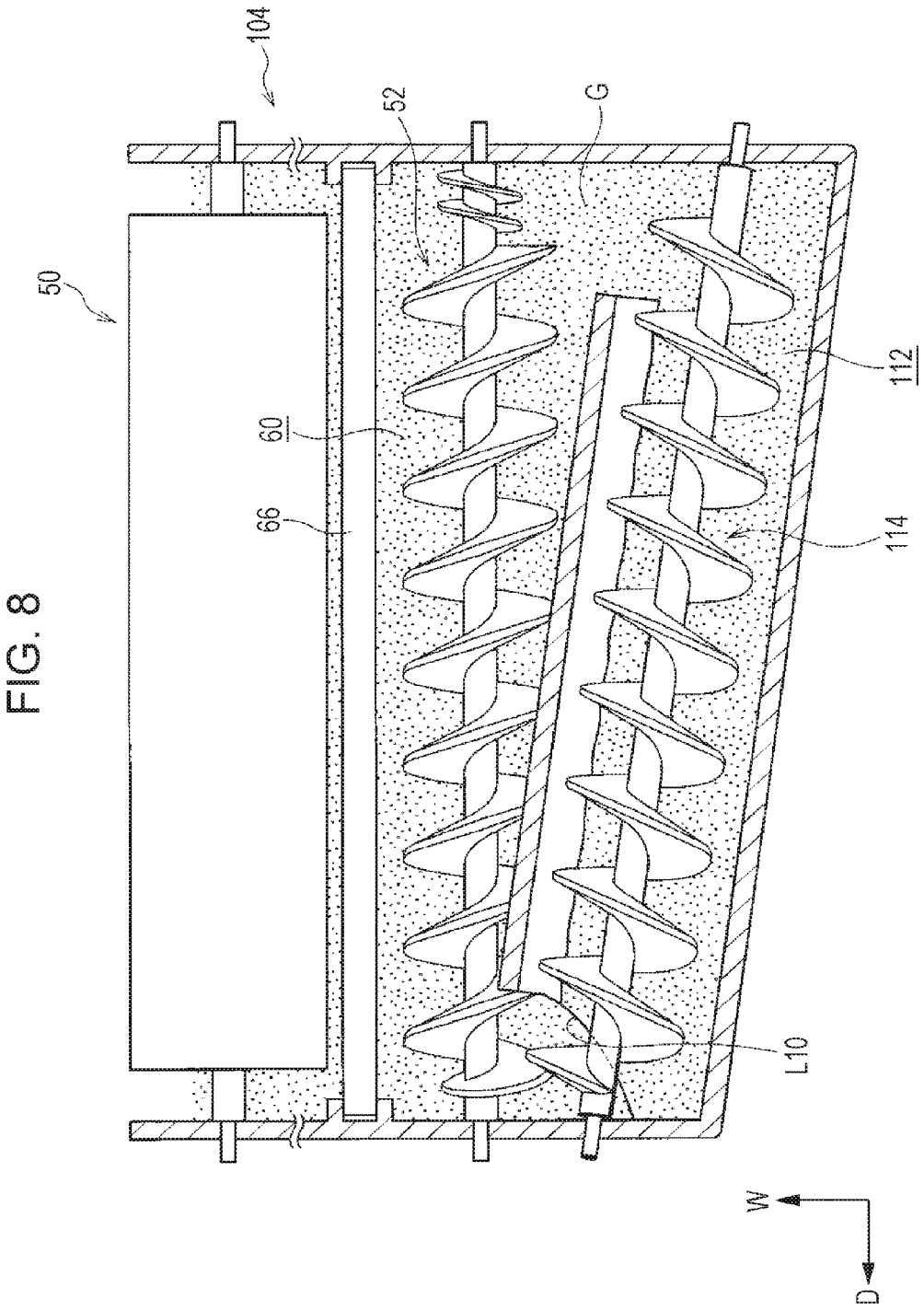


FIG. 7

FIG. 8



DEVELOPING DEVICE AND IMAGE FORMING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based on and claims priority under 35 USC 119 from Japanese Patent Application No. 2015-122179 filed Jun. 17, 2015.

BACKGROUND

Technical Field

The present invention relates to a developing device and an image forming apparatus.

SUMMARY

According to an aspect of the invention, there is provided a developing device including a developing member that delivers a developer to an image carrier while rotating, a transport-supply member that extends in one direction and that supplies the developer, which contains a toner, to the developing member while transporting the developer from a first side to a second side in the one direction, and a transport-stirring member that is disposed along a transport-stirring path, which is inclined in an upward direction with respect to a horizontal direction, the transport-stirring member being configured to receive the developer, which is transported by the transport-supply member, from a portion of the transport-supply member on the second side in the one direction, stir the received developer while transporting the developer upward along the transport-stirring path, and deliver the developer to a portion of the transport-supply member on the first side in the one direction.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the present invention will be described in detail based on the following figures, wherein:

FIGS. **1**A and **1**B are sectional views each illustrating a stirring auger and a transport-stirring path that are included in a developing device according to a first exemplary embodiment of the present invention;

FIG. **2** is a front view illustrating the stirring auger, the transport-stirring path, a supply auger, and a transport-supply path that are included in the developing device according to the first exemplary embodiment of the present invention;

FIG. **3** is a sectional view illustrating the stirring auger, the transport-stirring path, the supply auger, and the transport-supply path of the developing device according to the first exemplary embodiment of the present invention;

FIG. **4** is a sectional view illustrating the developing device according to the first exemplary embodiment of the present invention;

FIG. **5** is a cross-sectional view illustrating the developing device according to the first exemplary embodiment of the present invention;

FIG. **6** is a schematic diagram illustrating an image forming apparatus according to the first exemplary embodiment of the present invention;

FIG. **7** is a cross-sectional view illustrating a developing device according to a second exemplary embodiment of the present invention; and

FIG. **8** is a sectional view illustrating the developing device according to the second exemplary embodiment of the present invention.

DETAILED DESCRIPTION

First Exemplary Embodiment

An example of a developing device according to a first exemplary embodiment of the present invention and an example of an image forming apparatus according to the first exemplary embodiment of the present invention will be described with reference to FIG. **1**A to FIG. **6**. Note that, in each of the drawings, arrow H, arrow W, and arrow D respectively indicate a top-bottom direction of the developing device and the image forming apparatus (vertical direction), a width direction of the developing device and the image forming apparatus (horizontal direction), and a depth direction of the developing device and the image forming apparatus (horizontal direction).

(Overall Configuration)

As illustrated in FIG. **6**, in an image forming apparatus **10** according to the first exemplary embodiment, an accommodating unit **14**, a transport unit **16**, and an image forming unit **20** are disposed in this order from the lower side to the upper side in the top-bottom direction (direction of arrow H). Sheet members P, each of which serves as a recording medium, are accommodated in the accommodating unit **14**. The transport unit **16** transports the sheet members P, which are accommodated in the accommodating unit **14**. The image forming unit **20** performs image formation on the sheet members P, which are to be transported from the accommodating unit **14** by the transport unit **16**, one at a time.

[Accommodating Unit]

The accommodating unit **14** includes three accommodating members **26** each of which is capable of being drawn out in the depth direction of the image forming apparatus **10** from an apparatus body **10**A of the image forming apparatus **10**, and the sheet members P are stacked in the accommodating members **26**. Each of the accommodating members **26** is provided with a delivery roller **30** that sends out the sheet members P, which are stacked in the corresponding accommodating member **26**, one at a time to the transport unit **16**.

[Transport Unit]

The transport unit **16** includes plural transport rollers **32** each of which transports the sheet members P one at a time.

[Image Forming Unit]

The image forming unit **20** includes an image carrier **36** and a charging roller **38**, which is an example of a charging device that charges a surface of the image carrier **36**. The image forming unit **20** further includes an exposure device **42** and a developing device **40**. The exposure device **42** exposes the charged surface of the image carrier **36** to exposure light on the basis of image data so as to form an electrostatic latent image. The developing device **40** develops the electrostatic latent image so as to visualize the electrostatic latent image as a toner image.

The image forming unit **20** includes a transfer roller **46** and a fixing device **44**. The transfer roller **46** transfers a toner image, which has been formed on the surface of the image carrier **36**, onto one of the sheet members P, which is transported along the transport unit **16**, and the fixing device **44** fixes the toner image, which has been transferred to the sheet member P, onto the sheet member P by applying heat and pressure to the toner image.

Note that the developing device **40** will be described in detail later.

(Effects of Overall Configuration)

In the image forming apparatus **10**, an image is formed in the following manner.

First, the charging roller **38**, to which a voltage has been applied, uniformly and negatively charges the surface of the image carrier **36** to a predetermined potential by being brought into contact with the surface of the image carrier **36**. Next, the exposure device **42** radiates the exposure light onto the charged surface of the image carrier **36** on the basis of image data input from the outside and forms an electrostatic latent image.

As a result, an electrostatic latent image corresponding to the image data is formed on the surface of the image carrier **36**. Subsequently, the developing device **40** develops the electrostatic latent image so as to visualize the electrostatic latent image as a toner image.

Then, one of the sheet members P, which has been sent from one of the accommodating members **26** to the transport unit **16** by the corresponding delivery roller **30**, is sent to a transfer position T at which the image carrier **36** and the transfer roller **46** are in contact with each other. At the transfer position T, the sheet member P is transported by the image carrier **36** and the transfer roller **46** while being sandwiched therebetween, so that the toner image, which has been formed on the surface of the image carrier **36**, is transferred onto the sheet member P.

After that, the fixing device **44** fixes the toner image, which has been transferred to the sheet member P, onto the sheet member P. Finally, the sheet member P, to which the toner image has been fixed, is ejected to outside the apparatus body **10**A by the transport rollers **32**.

(Configuration of Principal Portion)

The developing device **40** will now be described.

As illustrated in FIG. **5**, the developing device **40** includes a developing roller **50** and a layer-thickness controlling roller **66**. The developing roller **50** is disposed in such a manner as to face the image carrier **36**, and the layer-thickness controlling roller **66** controls the layer thickness of a developer G on the developing roller **50**. The developing device **40** further includes a supply auger **52**, which is an example of a transport-supply member that supplies the developer G to the developing roller **50**, a stirring auger **54**, which is an example of a transport-stirring member that stirs the developer G, and a housing **56** in which the above-mentioned members of the developing device **40** are accommodated.

Note that the developer G is a two-component developer that contains a toner and magnetic carrier particles.

[Developing Roller and Layer-Thickness Controlling Roller]

The developing roller **50** has a rotary shaft extending in the depth direction of the developing device **40** (hereinafter referred to as device-depth direction) and is arranged in such a manner that a gap (development gap) is formed between the developing roller **50** and the image carrier **36** as illustrated in FIG. **5**.

The developing roller **50** includes a magnet roller **50**A having a circular cross section and a rotary sleeve **50**B. The rotary sleeve **50**B covers the magnet roller **50**A and rotates around the magnet roller **50**A. The rotary sleeve **50**B receives a force that causes the rotary sleeve **50**B to rotate from a driving source (not illustrated) and rotates in the direction of arrow C in FIG. **5** (clockwise direction).

The layer-thickness controlling roller **66** is disposed so as to oppose the image carrier **36** across the developing roller **50**. A gap is formed between the layer-thickness controlling roller **66** and the developing roller **50** in order to control the layer thickness of the developer G on the developing roller **50**.

[Supply Auger and Transport-Supply Path]

When viewed from the device-depth direction, the supply auger **52** is positioned diagonally below the developing roller **50** and is disposed in a transport-supply path **60**. The transport-supply path **60** extends in the device-depth direction, which is an example of one direction, and is U-shaped when viewed in cross section. As illustrated in FIG. **4**, the supply auger **52** includes a rotary shaft **52**A that extends in the device-depth direction and a helical blade **52**B that extends in a helical manner and that is formed on the outer peripheral surface of the rotary shaft **52**A. The rotary shaft **52**A is rotatably supported by a wall portion of the housing **56**, and a gear (not illustrated) that receives a rotational force from the driving source is fixed to an end of the rotary shaft **52**A.

With this configuration, the supply auger **52**, which rotates, transports the developer G from a far side (left side in FIG. **4**) to a near side (right side in FIG. **4**) in the device-depth direction (i.e., from a first side to a second side in one direction) while stirring the developer G in the transport-supply path **60** and supplies the developer G to the developing roller **50**.

[Stirring Auger and Transport-Stirring Path]

When viewed from the top direction, the stirring auger **54** is disposed so as to oppose the developing roller **50** across the supply auger **52**.

As illustrated in FIG. **2** and FIG. **3**, the stirring auger **54** is disposed along a transport-stirring path **62** that extends in a direction that is inclined with respect to the device-depth direction (horizontal direction) and that is U-shaped when viewed in cross section. As illustrated in FIG. **4**, a partition wall **64** is formed between the transport-stirring path **62** and the transport-supply path **60**. The partition wall **64** isolates the transport-stirring path **62** and the transport-supply path **60** from each other with the exception of portions of the transport-stirring path **62** and the transport-supply path **60** on the far side in the device-depth direction and portions of the transport-stirring path **62** and the transport-supply path **60** on the near side in the device-depth direction.

More specifically, the portion of the transport-stirring path **62** on the near side in the device-depth direction (right side in FIG. **2** and FIG. **3**) and the portion of the transport-supply path **60** on the near side in the device-depth direction are positioned at a similar level in the top-bottom direction. In other words, when viewed from the width direction of the developing device **40**, the portion of the transport-stirring path **62** on the near side in the device-depth direction is superposed with the portion of the transport-supply path **60** on the near side in the device-depth direction.

In addition, in the top-bottom direction, the portion of the transport-stirring path **62** on the far side in the device-depth direction (left side in FIG. **2** and FIG. **3**) is positioned at a level higher than that at which the portion of the transport-supply path **60** on the far side in the device-depth direction is positioned. Consequently, the transport-stirring path **62** and the stirring auger **54** extend in the direction that is inclined with respect to the device-depth direction (horizontal direction).

As illustrated in FIG. **4**, the stirring auger **54** includes a rotary shaft **54**A and a helical blade **54**B that extends in a helical manner and that is formed on the outer peripheral surface of the rotary shaft **54**A. The rotary shaft **54**A is rotatably supported by the wall portion of the housing **56**,

and a gear (not illustrated) that receives a rotational force from the driving source is fixed to an end of the rotary shaft **54**A.

With this configuration, as illustrated in FIG. **4**, a portion of the stirring auger **54**, which rotates, on the near side in the device-depth direction receives the developer G, which is transported by the supply auger **52**, from the supply auger **52**. Then, as illustrated in FIG. **2**, the stirring auger **54**, which rotates, transports the developer G upward from the near side in the device-depth direction (right side in FIG. **2**) to the far side in the device-depth direction (left side in FIG. **2**) along the transport-stirring path **62** while stirring the developer G. In addition, a portion of the stirring auger **54**, which rotates, on the far side in the device-depth direction delivers the developer G to the supply auger **52**.

(Effects of Configuration of Principal Portion)

Effects of the developing device **40** will now be described.

In the housing **56** of the developing device **40**, as illustrated in FIG. **4**, the supply auger **52**, which rotates, and the stirring auger **54**, which rotates, stir the developer G by transporting the developer G in the direction of arrows illustrated in FIG. **4** in such a manner that the developer G circulates. As a result of the developer G being stirred, the toner and the carrier are rubbed against each other, and the toner is triboelectrically-charged to a predetermined potential.

Then, as illustrated in FIG. **5**, the supply auger **52**, which rotates, supplies the developer G to the developing roller **50**. The developer G, which has been supplied to the developing roller **50**, is held on a surface of the developing roller **50** in a state of forming a magnetic brush (not illustrated) by the magnetic force of the magnet roller **50**A.

The rotary sleeve **50**B, which rotates, transports the developer G, and the layer-thickness controlling roller **66** controls the layer thickness of the developer G held on the developing roller **50** (rotary sleeve **50**B).

In addition, the rotary sleeve **50**B, which rotates, transports the developer G, whose layer thickness has been controlled by the layer-thickness controlling roller **66**, to a position facing the image carrier **36**. Then, only the toner, which is included in the developer G that has been transported to the position facing the image carrier **36**, is deposited onto the electrostatic latent image, which has been formed on the image carrier **36**, and as a result, the electrostatic latent image is visualized as a toner image. More specifically, the toner, which has been charged to a predetermined potential, is deposited onto the electrostatic latent image, which has been formed on the image carrier **36**, by an electrostatic force, and as a result, the electrostatic latent image is visualized as a toner image.

Here, as illustrated in FIG. **2**, the stirring auger **54**, which stirs the developer G, and the transport-stirring path **62**, in which the stirring auger **54** is disposed, are inclined with respect to the device-depth direction (horizontal direction). Thus, as illustrated in FIGS. **1**A and **1**B, part of the developer G (hereinafter referred to as a developer G**1** for convenience of description) that is transported by the stirring auger **54** and part of the developer G (hereinafter referred to as a developer G**2** for convenience of description) that is present between the stirring auger **54** and a wall surface of the transport-stirring path **62** are present in the transport-stirring path **62**.

The stirring auger **54**, which rotates, applies to the developer G**1** a force that forcibly causes the developer G**1** to be transported upward along the transport-stirring path **62**. On the other hand, this force that is applied by the stirring auger **54**, which rotates, does not directly act on the developer G**2**, and thus, a force that causes the developer G**2** to be transported downward along the transport-stirring path **62** acts on the developer G**2** due to gravity.

Thus, the developer G**1** and the developer G**2** rub against each other at an interface between the developer G**1** and the developer G**2**. Note that, in the case where the stirring auger **54** is arranged so as to extend in the horizontal direction, the force that causes the developer G**2** to be transported downward will not act on the developer G**2** due to gravity, and thus, the developer G**1** and the developer G**2** will not rub against each other.

Second Exemplary Embodiment

An example of a developing device according to a second exemplary embodiment of the present invention and an example of an image forming apparatus according to the second exemplary embodiment of the present invention will now be described with reference to FIG. **7** and FIG. **8**. Note that members and the like that are the same as those of the first exemplary embodiment are denoted by the same reference numerals, and descriptions thereof will be omitted. Portions that are different from those of the first exemplary embodiment will be described.

As illustrated in FIG. **7** and FIG. **8**, when viewed from above, a stirring auger **114** and a transport-stirring path **112** that are included in a developing device **104** according to the second exemplary embodiment are inclined with respect to a depth direction of the developing device **104** (hereinafter referred to as device-depth direction). In addition, when viewed from above, a portion of the stirring auger **114** on a far side in the device-depth direction, which is one side in one direction, is superposed with a portion of the supply auger **52** on the far side in the device-depth direction, which is the one side in the one direction.

A portion of a bottom portion of the transport-stirring path **112** on the far side in the device-depth direction is cut away in such a manner that the developer G, which has been transported by the stirring auger **114**, falls due to gravity and is delivered to the supply auger **52**. Note that a notch line of the portion of the transport-stirring path **112** on the far side in the device-depth direction is indicated by a line L**10** illustrated in FIG. **9**.

The rest of the effects are similar to those of the first exemplary embodiment.

Note that although the specific exemplary embodiments of the present invention have been described in detail, the present invention is not limited to the exemplary embodiments, and it is obvious to those skilled in the art that the present invention may employ other various exemplary embodiments within the scope of the present invention. For example, in the above-described first and second exemplary embodiments, the portion of the transport-stirring path **62** and the portion of the transport-stirring path **112** on the near side in the device-depth direction are each positioned at a level similar to that at which the transport-supply path **60** is positioned. However, the portion of the transport-stirring path **62** and the portion of the transport-stirring path **112** on the near side in the device-depth direction may be positioned at a level lower than that at which the transport-supply path **60** is positioned as long as the transport-stirring path **62** and the transport-stirring path **112** are inclined with respect to the horizontal direction and transport the developer G upward.

In addition, although the two-component developer has been described as an example in the above-described exemplary embodiments, a mono-component developer may be used.

Furthermore, although not particularly described in the above-described second exemplary embodiment, at least part of the developer G, which is transported by the stirring auger **114**, may drop due to gravity and be delivered to the supply auger **52**.

The foregoing description of the exemplary embodiments of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obviously, many modifications and variations will be apparent to practitioners skilled in the art. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, thereby enabling others skilled in the art to understand the invention for various embodiments and with the various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the following claims and their equivalents.

What is claimed is:

1. A developing device comprising:

a developing member that delivers a developer to an image carrier while rotating;

a transport-supply member that extends in one direction and that supplies the developer, which contains a toner, to the developing member while transporting the developer from a first side to a second side in the one direction;

a transport-stirring member that is disposed along a transport-stirring path, which is inclined in an upward direction with respect to a horizontal direction, the transport-stirring member being configured to receive the developer, which is transported by the transport-supply member, from a portion of the transport-supply member on the second side in the one direction, stir the received developer while transporting the developer upward along the transport-stirring path, and deliver the developer to a portion of the transport-supply member on the first side in the one direction;

a transport-supply path in which the transport-supply member is disposed; and

a transport-stirring path in which the transport-stirring member is disposed,

wherein the transport-supply member is disposed below the developing member and transports the developer along the transport-supply path, and

wherein a lowest portion of the transport-stirring path on the second side and a lowest portion of the transport-supply path on the second side are located at a substantially similar level in a top-bottom direction of the developing device.

2. The developing device according to claim **1**,

wherein a portion of the transport-stirring member on the first side in the one direction is superposed with the portion of the transport-supply member on the first side in the one direction when viewed from above, and

wherein at least part of the developer, which is to be delivered to the transport-supply member by the portion of the transport-stirring member on the first side in the one direction, is delivered as a result of being dropped from the transport-stirring path.

3. An image forming apparatus comprising:

an image carrier on which an electrostatic latent image is to be formed;

the developing device according to claim **2** that develops the electrostatic latent image formed on the image carrier into a toner image; and

a transfer device that transfers the toner image formed on the image carrier onto a recording medium.

4. An image forming apparatus comprising:

an image carrier on which an electrostatic latent image is to be formed;

the developing device according to claim **1** that develops the electrostatic latent image formed on the image carrier into a toner image; and

a transfer device that transfers the toner image formed on the image carrier onto a recording medium.

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